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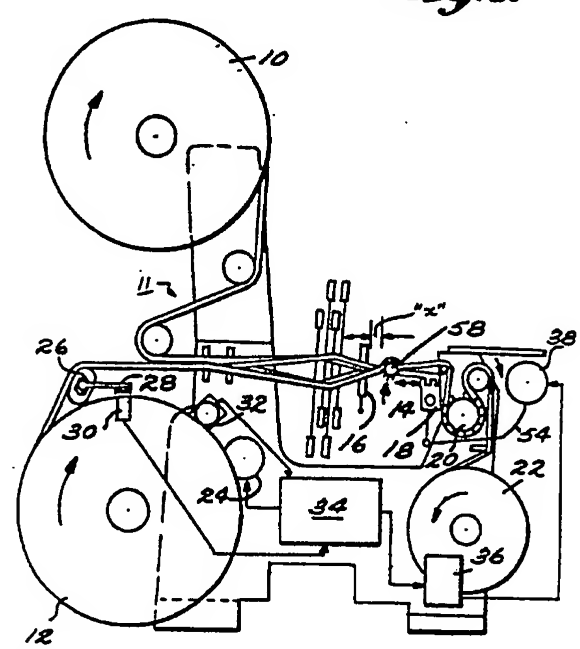
(54) Terry loop ratio control device.

(57) The pile-to-ground warp yarn ratio of terry cloth is controlled during the weaving operation by sensing both the tension imposed on the pile warp and the amount of pile warp yarn dispensed from the supply beam. The sensed information is used to control the speed of a pile warp let-off motor which dispenses the pile warp yarn from its beam. Additionally, the sensed information is employed to selectively alter the displacement of a rocking bar to vary the height of the terry loop formed in the cloth.

Fig. 1.



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TERRY LOOP RATIO CONTROL DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to the manufacture of terry cloth and, in particular, to apparatus for achieving a uniform ratio of pile to the ground warp which constitutes the fabric's foundation.

For many years terry cloth was produced utilizing conventional fly shuttle looms. Such looms weave a product with a uniform pile-to-ground warp ratio, but they typically operate at a relatively slow rate. More recently, however, fly shuttle looms have been replaced with high speed weaving machines such as the Models PU and TW.II looms produced by Sulzer Brothers Limited of Winterthur, Switzerland.

In a Sulzer machine, ground and pile warps move past an array of reciprocally operable reeds and a displaceable rocking bar. The ground warp continuously is dispensed from its supply beam, while the pile warp is dispensed incrementally from its supply beam under the control of a pile warp let-off motor. A weft or filling yarn is inserted between the reeds and the movable rocking bar in the weaving operation, and as the reeds are displaced towards the rocking bar during their reciprocation, the filling yarn is carried by the reeds to the fell of the cloth being woven.

In a typical weaving cycle, the rocking bar is maintained at a first position as the filling yarn is carried to the fell twice in succession in the manner just described. Before the reeds are displaced a third time, however, the pile warp letoff motor dispenses pile yarn, and the rocking bar is displaced to move the fell of the cloth towards the reeds. As a result, when the reeds carry the filling yarn to the fell of the cloth, loops of the pile yarn are formed in a row across the top and bottom of the base fabric. The rocking bar then is withdrawn to its initial position to permit the three-pick weaving cycle just described to be repeated.

The height of the loops in terry cloth is very important to its acceptability. In a typical high pile terry, approximately 55% of the total fabric is pile yarn. Any fluctuation in pile height (i.e., a change in the pile-to-ground warp ratio) has an adverse effect on the fabric's weight and appearance.

Two kinds of pile warp let-off can be used in a terrying operation. The first is a positive type pile let-off, a mechanically-linked device which lets-off a predetermined amount of terry yarn based on a mechanical adjustment. The second type --employed in a Sulzer machine --is a negative pile let-off motor which controls let-off independency on pile warp tension, the amount of terry yarn dispensed being that required to maintain constant tension on the pile warp.

Terry looms with a motorized negative-type let-off attempt to control the pile-to-warp yarn ratio by monitoring the tension of pile yarn at a location near its supply beam. More particularly, the ends of pile yarn pass over a flexible whip roller as they are fed into the loom. A metallic flag is secured to the roller so as to move towards or away from the pile yarn supply beam as the roller flexes in response to the amount of tension applied to the pile warp ends. A proximity sensor is mounted adjacent the flag. This sensor produces an output voltage having a magnitude dependent on the distance between it and the flag. As tension on the pile warp ends changes, the flag's movement alters the sensor's output voltage. This outpout voltge is supplied to the circuitry to produce signals for increasing or decreasing the speed of the pile warp let-off motor to alter the amount of pile yarn dispensed from its supply beam thus maintaining constant tension on the yarn. As the pile warp tension increases, the pile warp let-off motor accelerates so as to decrease the tension. Conversely, a lowering of pile warp tension results in the pile warp let-off motor being slowed in order that the pile warp tension will increase.

While the arrangement just described contributes to the control of the pile-to-ground warp ratio by maintaining the tension of the pile warp within a normal operating range, the terry height nevertheless still varies by an unacceptable amount.

SUMMARY OF THE INVENTION

The present invention results from the recognition that a pile-to-ground warp ratio can be maintained substantially uniform by controlling not only the pile warp tension, but also the distance the rocking bar moves during the weaving operation. Since adjustment of the amount of rocking bar displacement in a terry loom with a motorized negativetype let-off is performed manually when the machine is stopped, such adjustment cannot be employed for continuously controlling the pile-to-ground warp ratio. The present invention provides means, however, for automatically adjusting both the distance the rocking bar moves and the tension of the pile warp in order to maintain the pile-to-ground warp ratio substantially constant, thereby producing uniform terry.

BRIEF DESCRIPTION OF THE INVENTION

IN THE DRAWINGS:

The invention now will be described in greater detail with respect to the accompanying drawings which illustrate a preferred embodiment of the invention, wherein:

FIG. I is a side elevational view illustrating the general arrangement of a terry weaving machine according to the present invention;

FIG. 2 is a block diagram of electronic circuitry employed for controlling the pile-to-ground warp ratio; and

FIG. 3 is an enlarged view, partially in section, illustrating the structure by which displacement of the rocking bar, shown generally in FIG. I, is adjusted.

Referring to FIG. I, the weaving machine illustrated includes a groundwarp supply beam I0 and a pile warp supply beam I2. Yarn from each of these beams is directed around rollers and past harnesses to the area I4 where weft or filling yarn (not shown) is woven through the warp yarns in the customary fashion. Area I4 lies between an oscillating array of reeds I6 and a rocking bar I8, the latter being reciprocally movable along a path extending in the direction of warp yarn travel. As they move towards bar I8, the reeds I6 positively carry the filling yarn to the fell of the cloth being woven. The cloth thereafter moves past a needle-type take-up beam 20 which rotates at constant speed, and then the cloth is collected by a final beam 22.

The ground warp yarn is removed continuously from beam I0. The rate of removal is controlled by the take-up beam 20. Thus, the amount of warp yarn dispensed from beam I0 is a known quantity which remains constant throughout the weaving operation. The pile warp yarn is dispensed from beam I2 in response to signals to the pile warp let-off motor 24.

As the pile warp yarn leaves beam I2, it passes over a flexible roller 26. A flat 28 is attached to roller 26, the outer end of the flag being positioned adjacent to a proximity sensor 30. When the tension on the pile warp varies, roller 26 flexes, thus altering the distance between the flag 28 and sensor 30. The sensor thereby produces an electrical output signal which is a function of pile warp tension.

An encoder 32 also is operably related to the pile warp yarn as it is discharged from beam I2. The encoder 32 rides on the pile warp yarn to produce an electrical signal which accurately indicates the amount of yarn dispensed when the beam I2 rotates.

The signals from the encoder 32 and sensor 30 are utilized in a manner now to be described in order to maintain a substantially constant pile-to-ground warp ratio.

As illustrated in FIG. 2, the output signal from encoder 32 is directed to circuitry 34 which includes a microprocessor. The circuitry also incorporates appropriate memory which stores information relating both to the amount of ground warp yarn dispensed as a constant quantity from beam I0 and programming for the microprocessor. With these inputs, the microprocessor continuously computes the pile-to-ground wapr ratio occurring as the loom operates. If the ratio departs from the preprogrammed desired level, the microprocessor's output, when combined with that developed by proximity sensor 30, produces a signal which alters the operation of the pile warp let-off motor 24. This is accomplished by applying the microprocessor and sensor outputs to a conventional summation circuit, the output of which is directed to that circuitry ("Sulzer Electronics") found in commercially available Sulzer machines. This circuitry performs basic timing and control functions necessary for loom operation. As it pertains to the present invention, one function of the Sulzer Electronics is to control pile warp tension. More particularly, the pile warp supply beam I2 is either speeded up or slowed down, in response to the pile warp tension, by varying the control signals to the motor. This causes either an increase in the amount of pile yarn dispensed when the pile-to-ground ratio is too low, or a decrease in the pile yarn dispenser when the ratio is too high. As a result, the tension of the pile warp is maintained constant.

The adjustability of the pile-to-ground warp ratio obtainable by varying the operation of pile warp let-off motor 24 is limited, however. Accordingly, the present invention provides additional control of the ratio by means now to be described.

The circuitry 34 includes conventional threshold detector means for the recognition of error in excess of a predetermined level. When this occurs, the detector's output is directed to a motor controller 36 which in turn is joined to a further pile warp let-off motor 38. This motor operates a lead screw arrangement (hereinafter described in detail) associated with rocking bar I8 so as to alter the displacement of bar I8. As a result, the minimum spacing "x" which occurs between the reeds I6 and the fell of the cloth being woven is altered. When spacing "x" increases, the height of the pile increases, while a decrease of the spacing "x" results in the pile height decreasing.

The signal from the threshold detector directed to motor controller 36 is of a predetermined interval only. Thus, the adjustment of the rocking bar I8 is incremental. This provides the circuitry 34 with an

opportunity to determine whether the adjustment of the displacement of bar 18 hs been sufficient to bring the pile-to-ground warp yarn ratio to a level where it can be controlled by the signals generated by sensor 30 and encoder 32. If an error sufficient to produce an ouput signal from the threshold detector persists after an incremental adjustment of rocking bar 18 occurs, another such adjustment is made. This process is repeated until the desired pile-to-group warp ratio can be attained solely by the operation of pile warp let-off motor 24.

The mechanical arrangement by which the rocking bar 18 is adjustably displaced is illustrated in FIG. 3. More particularly, bar 18 is secured to the upper end of an arm 40 which is pivotally connected to a stationary support member 42. Arm 40 is forked at its lower end, one portion of the fork being omitted from FIG. 3. for convenience of illustration. A horizontally disposed arm 44 is arranged with one of its ends located within the fork of arm 40. The other end of arm 44 is operatively connectd to a cam drive (not shown) which riciprocates the arm after each third pick of the weaving process to permit reeds 16 to "beat" the pile warp into the fell of the cloth being woven. The end of arm 44 located within the fork of arm 40 is provided with an elongated slot 46 to receive a pin 48 secured at its ends to the fork. A block 50 also is located within slot 46. The block is joined to a lead screw 52 threaded into arm 44. The lead screw 52 is joined by a flexible drive cable 54 to pile warp let-off motor 38. Thus, as motor 38 operates, block 50 is moved along slot 46. Repositioning of the block varies the degree of displacement imparted to the lower end of arm 40 by the uniform horizontal movement of arm 44 produced by the cam drive. The let-off motor 38 has associated with it a rotary limit switch 60 which is set to turn off the motor when the rocking bar 18 is adjusted to its maximum and minimum limits.

The rocking bar 18 is interconnected with a slide 56 which reciprocates horizontally in response to the arcuate movement of bar 18 caused when the lower end of arm 40 is displaced. Slide 56 carries at its outer end a spiked roll 58. The spikes penetrate the cloth produced by the weaving operation. Roll 58 turns only in response to the tension applied to the cloth by the take-up roll 20. Consequently, when the rocking bar 18 is displaced to permit the pile warp to be beaten into the fell, roll 58 supports the fell.

Changes in amount of movement of rocking bar 18 alter the amount of pile warp which is beaten into the fell. Stated otherwise, by increasing the displacement of bar 18 towards the reeds 16, a higher pile is developed, while reducing the travel of bar 18 towards the reeds lowers the pile height.

Since the electronics employed in the present invention recognize deviations from a desired pile-to-ground warp ratio, it is apparent that the error signals developed also can be used to energize suitable indicators to show when the cloth being produced is not within an acceptable range.

Claims

1. In a terry weaving machine of the kind including a first supply beam from which pile warp yarn is dispensed under the control of a negative type pile warp let-off motor, a second supply beam from which ground warp yarn continuously is dispensed, an array of reciprocally operable reeds and a rocking bar past which said pile and ground warp yarns are directed, said rocking bar being intermittently operable for displacement from a first position towards said reeds to a second position and then returning from said second position to the first position, the invention comprising:

means for sensing the tension on said pile warp yarn to produce a first electrical signal;

means for sensing the amount of pile warp yarn dispensed from the first supply beam to produce a second electrical signal;

circuit means responsive to said first and second signals and to signals representative of the amount of ground warp yarn continuously dispensed and a desired pile-to-ground warp ratio to produce first and second output signals, said first output signal being determined by a difference between the desired pile-to-ground warp ratio and an actual pile-to-ground warp ratio calculated by said circuit means, and said second output signal occurring when said difference exceeds a threshold level;

means for connecting the first output signal to said pile warp let-off motor to alter the amount of pile warp yarn dispensed; and

means responsive to said second output signal for altering the distance between the second position of the rocking bar and said reeds to alter the height of terry produced when the rocking bar is in the second position.

2. In a terry weaving maching of the type set forth in Claim 1, the invention further comprising:

a stepper motor operatively connected to the rocking bar to incrementally alter the distance between said second position and the reeds.

3. In a terry weaving machine of the type set forth in Claim 2, said rocking bar being positioned at one end of an arm pivotally supported between its ends, said stepper motor being operatively connected to the opposite end of said arm to alter the amount of pivotal movement of said arm.

4. In a terry weaving machine of the type set forth in Claim 3, wherein the operative connection between the stepper motor and the opposite end of the pivotally supported arm comprises:

a cam-driven arm having an elongated slot therein for receiving a pin joined to the end of said pivotally supported arm;

a block positioned within said slot for engagement with the pin to cause pivotal movement of the pivotally supported arm;

a lead screw joined to the cam-driven arm and to said block; and

means for connecting the stepper motor to the lead screw whereby energization of the stepper motor causes the block to be repositioned within the slot.

5. In a terry weaving machine of the type set forth in Claim I, said circuit means comprising: a microprocessor to which said second signal and the signals representative of the ground warp yarn dispensed and the desired pile-to-warp yarn ratio are supplied as inputs, said microprocessor producing first and second voltages, the first voltage being combined with said first signal to produce the first output signal, and said second voltage being applied to threshold detector logic to produce said second output signal when the threshold level established by the threshold detector logic is exceeded.

Fig. 1.

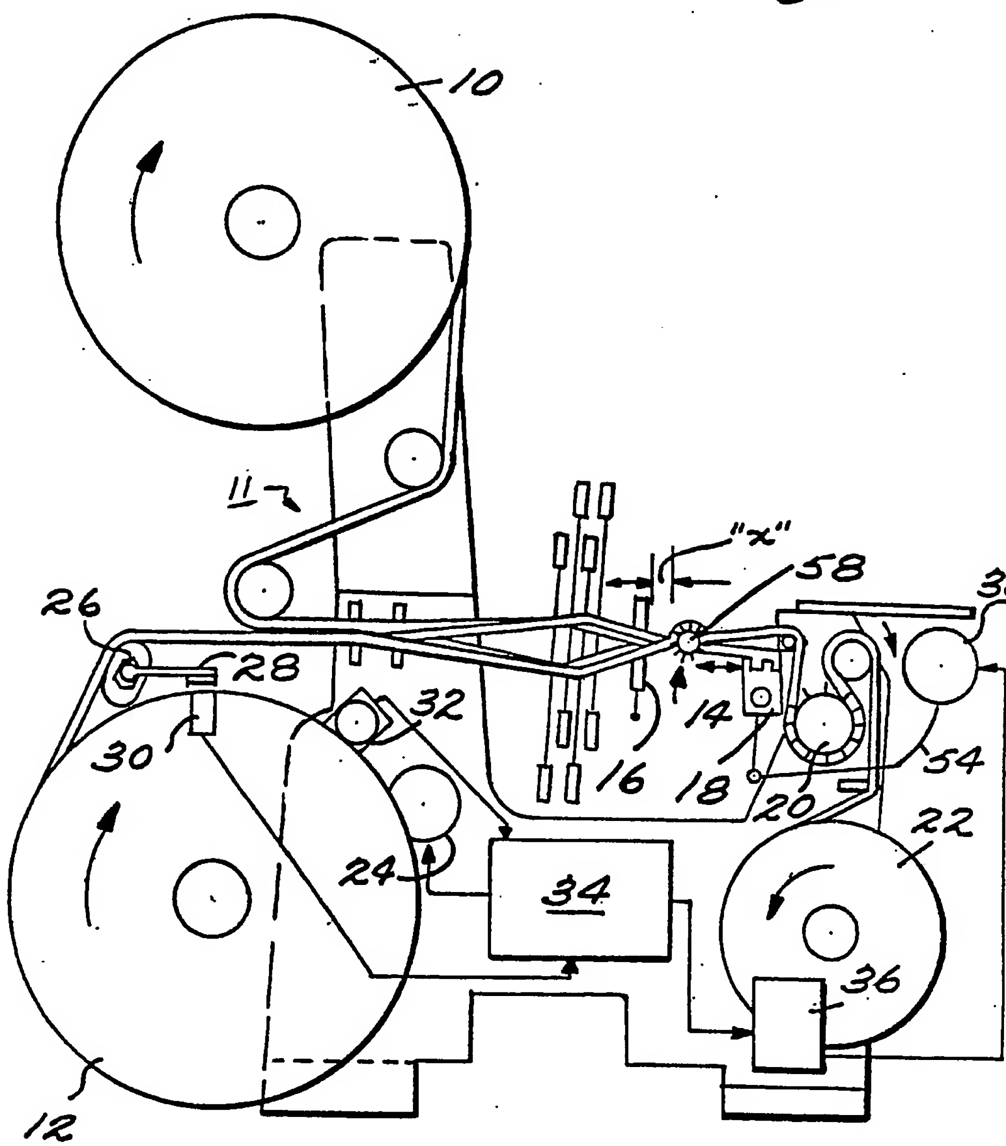


Fig.2.

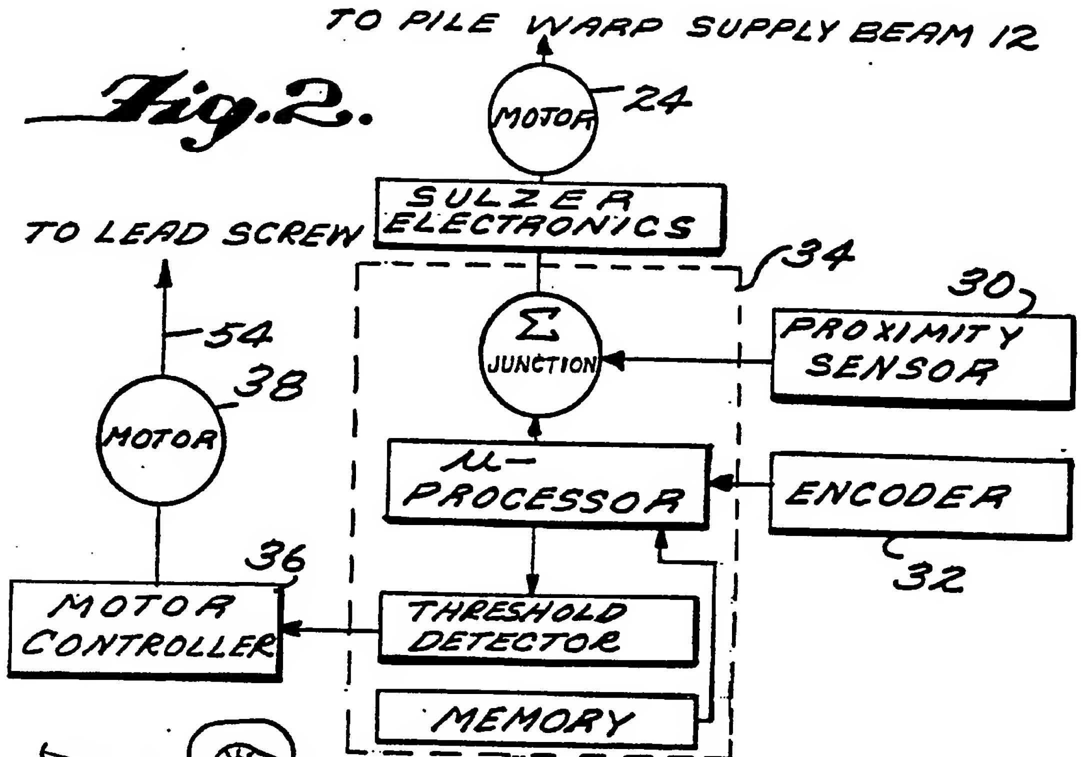
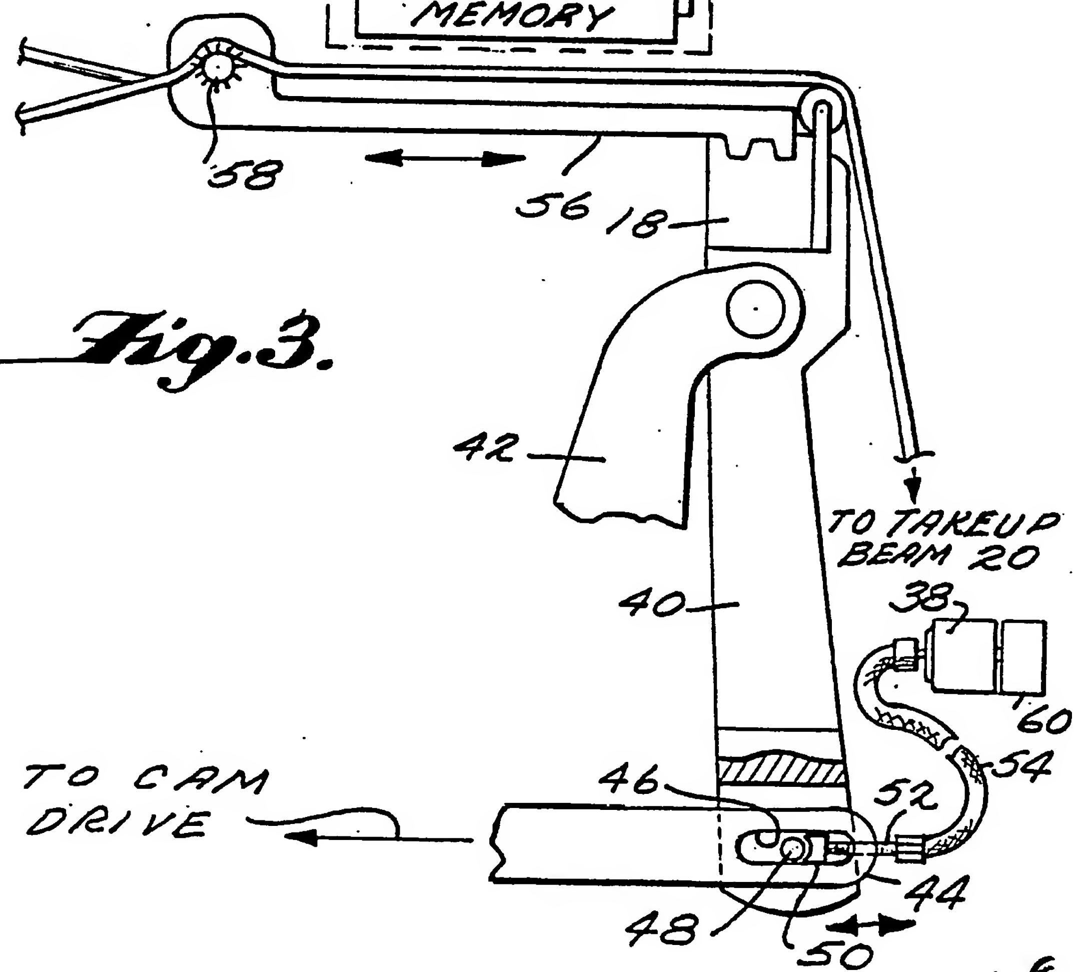

TO PILE WARP SUPPLY BEAM 12
MOTOR
24
SULZER ELECTRONICS
TO LEAD SCREW
34
30
Σ JUNCTION
PROXIMITY SENSOR
54
38
MOTOR
μ-PROCESSOR
ENCODER
32
36
MOTOR CONTROLLER
THRESHOLD DETECTOR
MEMORY

Fig.3.


58
56
18
42
TO TAKEUP BEAM 20
40
38
60
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TO CAM DRIVE
46
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